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ture to excretine, but not identical with it. They contain no excretine; they yield butyric acid, which is not present in human excrements.

2. The excrements of the Crocodile contain cholesterine and no uric acid, whilst those of the Boa yield uric acid and no cholesterine.

3. The fæces of herbivorous animals, viz. the Horse, Sheep, Dog (fed on bread), Wild Boar, Elephant, Deer and Monkey, contain no excretine, no butyric acid and no cholesterine.

XX. "On the Vine-Disease in the Port-wine Districts of the Alto-Douro, in April 1854. With a Supplementary Note on the Proposed Remedies for its Eradication." By JOS. JAMES FORRESTER, Esq., F.R.G.S. Communicated by J. P. GASSIOT, Esq., F.R.S. Received May 17, 1854.

In Portugal, where the vine-disease committed great ravages last year, no measures have as yet been adopted for ascertaining whether the disease is *radical*, or only superficial; or whether any *practical remedy* may be adopted in order to arrest the progress of the evil.

At Oporto, and in the north of Portugal, an opinion prevails—

"That the *Oidium* is the *effect*, and not the *cause* of the epidemic.

"That the roots and the wood of the vines are diseased.

"That *sporules* of the *Oidium* exist in the interior of the vine, and about its roots.

"That the obstruction to the ascent of the sap through the various ducts, originates in the roots.

"That black spots appear in the joints of the branches, indicating that disease exists throughout the body of the vine.

"That a new fungus has appeared on the vines, in the shape of small globules, containing carbonic acid.

And "that, although vegetation may continue for a while, the fruit will not ripen, and the vines will die in a couple of years from this date."

Considering that it would be of some importance to determine whether the disease has its origin in the roots or from external

causes, and with a hope that some practical cure for the diseased vines grown in the open air may be discovered, I record the results of my own observations of the progress of the vine-malady in the Alto-Douro.

The Port-wine District extends eight leagues west and east from the Serra do Marão (an elevation of 4400 feet* from the level of the sea) to the Quinta do Baleira, near Sam João da Pesqueira, and four leagues north and south, between Villa Real and the city of Lamego †.

The winter streams, tributaries to the Douro, on the right bank, are the Sermenha, Corgo, Ceira, Pinhão, and Tua; and, on the left, the Varoza, Temilobos, Tedo, Tavora, and Torto.

At Baleira, the Douro runs at an elevation of not more than 250 feet; whence some opinion may be formed of the nature and inequality of the country, and of the numerous abrupt mountain ridges, on the inclines of which the vines are grown. The Wine-Districts of the Alto-Douro form a long irregular basin, girt by the granite chains of the Tras-os-Montes and Beira; and this being for the most part of schist formation, and protected from the bleak winds, is particularly adapted for the cultivation of the vine. The strata of the margins of the Douro differ from the higher and middle grounds in character, "being composed of strong clays, more or less micaceous."

The extreme northern and southern boundaries—from the Serra do Marão to Favaios, and from the Serra do Monte Muro (near Lamego) to Sam João da Pesqueira—are undulating mountain plains of still heavier soil, and more suitable for the growth of firs than vines. In former years, this fact was clearly defined by the Royal Wine Company, who divided the districts into two, one being termed Feitoria (where the most superior wines were produced and classified for exportation), the other Ramo, where only very inferior wines, for the consumption of the country and for distillation, were produced to a small extent. Now, the two districts have become one; the plantations of pines on the heights and the corn-producing valleys having alike been converted into vineyards; the

* "Considerações geraes sobre a Constituição Geologica do Alto-Douro." By Dr. J. P. Rebello. Porto, 1848.

† See map of the Wine-Districts of the Alto-Douro. By J. J. Forrester.

quantity, and not the *quality*, of the produce being the results sought by the wine-grower within this privileged demarcation.

One thousand vines generally produce a pipe of wine, and the total number of vines in the Port-wine Districts above described may be estimated at 90,000,000.

In the summer time, there is great scarcity of water throughout the district. The vineyards are for the most part situated on abrupt mountain slopes, the vines being planted on terraces, which are not appropriate for the cultivation of anything else. The vines are grown not higher than three feet from the ground, and are planted about six feet apart, supported with canes or stakes. The labour in the vineyards is performed by the natives of Galicia, who visit the district three or four times a year in search of employment.

In July 1850, I first observed a blight on three or four vines, at a considerable distance from each other, in the Wine Districts. The general appearance of this blight to the naked eye greatly resembled that which appears on the peach-tree and the rose. The Douro farmers had often previously noticed a similar *po' branco* (white powder) on the vines.

In 1851 the season was favourable, and the vines (on which we had observed the blight in the previous year) were vigorous, and produced perfect fruit. The vintage of 1851, throughout the Alto-Douro, was excellent. In 1852 there was much wet and cold; the blight again appeared, and the vines were attacked to the extent of about one in fifteen hundred. The vintage of 1852 was of inferior quality; but no one ascribed the failure to any disease in the vine. From the autumn of 1852 until midsummer 1853, continued rain, sleet, hail, and bleak winds prevailed, and in 1853 there was no spring. In March of the same year the navigation of the Douro was impeded, and the bar rendered impassable on account of the floods; and in April and May of the same year, prayers were offered up in the churches throughout the Wine Districts for fine weather.

In March 1854, only half-cargoes could be brought down the river Douro, on account of the want of water, and rain was prayed for.

Early in June 1853, the heat became suddenly intense, and the vines had already burst forth with great vigour; whilst, in the middle of the same month, the nights became as cold as in winter.

In the most exposed situations the vines received the greatest shock ; the circulation of the sap was evidently deranged, and their fruit withered as soon as it appeared. In some neighbouring vineyards, less exposed, the grapes grew no larger than peas ; they were then suddenly covered with the blight (now designated the *Oidium*), and in about three days became rotten.

On the inclines of the mountains on either bank of the river Douro, the waters had run off, and but little blight appeared. In the low and heavy grounds, the most sheltered from the winds, the waters remained stagnant ; yet the fruit grew to its full size, and had come to maturity, when the new wood, leaves, and fruit were all, to a greater or less degree, covered with the *Oidium*. The blight sometimes attacked entire vineyards, and at other times only partially affected one property, and then showed itself in others at a distance—intermediate estates being for the time wholly untouched.

It was in July 1853 that the existence of the disease in the vineyards of the Douro first attracted particular attention ; but many vines betrayed no unhealthy symptoms until the fruit was nearly ripe. The upper part of the branches was first attacked. In some instances the woody part of the young branches was speckled with the *Oidium*, while the bunches of fruit were apparently altogether free from it. In other instances, the grapes became touched with the disease immediately before the vintage, but the woody part of the branches betrayed no such symptoms. In some vines, which I supposed had altogether escaped the disease (and long after the fruit was gathered and the leaves had fallen off), blotches or stains, evidently the *mycelium* of the *Oidium*, appeared on the wood.

The usual number of seeds in a black grape is two or three ; but in the year 1853, in all instances the grapes, which at first promised abundance of wine, were found each to contain from three to five seeds.

Twenty-one baskets of grapes usually produce one pipe of wine ; but in the year 1853, a pipe of wine was rarely obtained even from thirty baskets of grapes. From seven to nine pipes of ordinary wine generally give a pipe of brandy, 20 per cent. above British proof ; but in the year 1853, from ten to twelve pipes of ordinary wine were required to give one pipe of brandy of that strength.

Wines, when properly made, should be trodden continuously for 36 hours in the *lugar* (an open stone vat), and remain there for 36 to 48 hours more, until the tumultuous fermentation be completed, when they should be run off into larger *tonels* (wooden vats, not tightly bunged), where the second fermentation will be completed about Christmas. In 1853, in situations where the disease most prevailed, the grapes fermented before they had been trodden more than twelve hours, when the wines were drawn off and passed into tonels, where brandy, as a precautionary measure, was given to them. The fermentation of these wines ceased altogether before the 15th October. In other situations, where the disease had not made progress, the grapes were sound; and, where they were properly crushed and fermented, they produced excellent wine, without the addition of brandy.

Wines, during their second fermentation, deposit a thick coating of argol on the sides of the tonels. In 1853 there was very little argol deposited; but the gross lees of the wine were in great demand, and sold for about 15s. per basket,—a sum which in former years might almost have purchased double the quantity of grapes.

In the same manner as the form and colour of the wood, leaves, and fruit of vines differ, so does their pith vary in appearance, according to the age of the wood or the quality of the vine. The pith in an old vine, when the sap is rising, graduates from a deep vandyke-brown colour to a pale yellow, the shade being always darker near the joints.

In April 1854, I rooted up many vines of different qualities, and in various situations, and I was unable then to detect any remarkable appearance in the interior of the vine different from what I had seen in other years after continued wet and cold weather; but the exterior of all the last year's branches bore palpable evidence of having been violently attacked with the *Oidium*. Some vines had suffered more than others, and many of their vessels were evidently choked; but, in most instances, in cutting the vine longitudinally, this obstruction was found to have arisen either from wounds, bad pruning, or natural decay. I found no black spots at the joints of the branches; and, with the exception of the stains left by the disease of last year, the vines looked healthy and vigorous, throwing out strong shoots and promising an abundance of fruit.

Towards the end of April 1854, much rain fell in the district ; the easterly winds destroyed the young branches ; and in the most exposed situations and heavy soils the *Oidium* again made its appearance.

In 1853, the disease attacked the vines bodily, and almost simultaneously : whereas, in 1854, the *Oidium* appears to be creeping out of the skin of the last year's wood, and insidiously to extend itself over the branches.

The globules (to which allusion has been made above) cover the young shoots. I have been familiar with these for twenty-three years past, and the Douro farmers call them the " perspiration " of the vine. They do not indicate disease, whereas the smallest possible quantity of the *po' branco*, or white powder, being transferred to a perfectly healthy vine, immediately infected it.

In the Alto-Douro the oranges, lemons, citrons and limes have all been blighted, and every kind of vegetable appears to be suffering from sickness.

The vines which suffered most in the Alto-Douro, in 1853, were the Muscatel, Malvazia, Alvarilhão, Ferral, Agadanho and Senzão.

Since my arrival in this country I have noticed that the vines grown on walls in the open air, vines grown in greenhouses, vines grown in hot-houses, vines forced, all show identically the same effects of the *Oidium* of last year, as exist on the vines in the Alto-Douro.

Taking into consideration all the circumstances above narrated, I have come to the conclusion,—

That the *Oidium* is the *cause*, and not the *effect* of the disease ; that the inclemency of the season in 1853, by checking the circulation of the sap in the vines, produced a predisposition for disease ; that if the *Oidium* continues to appear on the branches of the vines, it is only too probable that it may in a very few years be destroyed ; that the *globules* are a sign of health and not of disease, and have no connexion whatever with the fungus called *Oidium* ; and that if the germ of the *Oidium*, probably still lurking on the old branches, can be destroyed in the open air as effectually as it appears to have been destroyed under glass, then I feel persuaded that all the vines in the Port-wine districts of the Alto-Douro may be saved.

“Supplementary Note on the proposed Remedies for the Eradication of the Vine-Malady.” Received June 1, 1854.

1st. I will take the annual production of wines in the Port-wine districts of the Alto-Douro at 80,000 pipes instead of 90,000, and the number of vines to be treated as diseased at 80,000,000.

2nd. The value of freehold land in that district, for the growth of 1000 vines, or one pipe of wine, may be estimated at 50*l.*, yielding an interest or rental of 3*l.* per annum.

3rd. The total freehold value of the vineyards in those districts may be estimated at 4,000,000*l.* sterling, giving an annual revenue of 240,000*l.*

4th. In the event of the disease not being checked in its progress, and the grapes being destroyed this year in the Alto-Douro, a *minimum* loss of 240,000*l.* will be sustained, and should the vines perish, the loss may be 4,000,000*l.*

5th. Portugal is said to produce annually 1,000,000 pipes of wine of all sorts and qualities, but I will estimate the total production at 800,000 pipes, and the total number of vines in the country at 800,000,000.

If *Flour of Sulphur* be used, the leaves, branches and shoots are first moistened as equally as possible with a syringe; then the whole is dusted with sulphur, which adheres to the moistened surface.

This operation would have to be repeated thrice, and would consume two ounces of sulphur for every vine, in each of the operations, making a total of 480,000,000 ounces, or about 13,392 tons for the treatment of the 80,000,000 vines in the Alto-Douro, and 133,920 tons for the vines of the whole country.

Sulphur would not cost less than 10*l.* per ton, delivered in the centre of the Alto-Douro districts, or in any other part of the interior of Portugal. The expense of sulphur required for the Douro would be 133,920*l.*, and for the whole country 1,339,200*l.*

One man could moisten one vine in one minute, and another man could dust it with sulphur in the same time, so that two men could perform the complete operation on about 700 vines daily, at a cost

of 1*s.* 3*d.* each man for labour, making a total of 14,285*l.* in the Alto-Douro, and 142,850*l.* for all Portugal.

I will suppose that there are 4000 vineyards in the Alto-Douro, planted each with 20,000 vines. The first cost of syringes and fumigators would amount to not less than 10*l.* for each vineyard, or a total of 40,000*l.* for the Alto-Douro.

One quart of water would be required for every vine in each operation, making a total of about 90,000 pipes, the cartage of which, and the labour of distributing it over the mountain vineyards, in tubs, on men's heads, would cost a minimum of 10*s.* per pipe, or a total of 45,000*l.* for the Alto-Douro, and 450,000*l.* for the whole country.

Recapitulation.

	In the Douro.	In the whole country.
For sulphur, say	£135,000	£1,350,000
For labour, at £15,000 for each of the three operations	45,000	450,000
For water, at £45,000 for each of the three operations, or as much as the sulphur.....	135,000	1,350,000
For instruments	40,000	400,000
	<u>£355,000</u>	<u>£3,550,000</u>

This is independent of any charge for factors or superintendents, or for the extra expense in treating vines and vineyards which are so much further apart than are those in the Alto-Douro.

This expense to be incurred in the endeavour to save one year's crop, would be equal to a charge of 4*l.* 10*s.* per pipe, or to a year and a half's rental of the vineyards, or to more than the whole revenue of Portugal for an entire year.

If a solution of lime and sulphur be employed instead of flour of sulphur, the operation would not be less expensive.

If, in conjunction with the sulphuring of the branches, the roots were to be exposed, and sulphur and lime thrown upon them, I could not estimate the total expense at less than 1½*d.* to 1¾*d.* per vine, which would entail a charge equal to another year and a half's

rental of the vineyards, or 18 per cent. on their freehold value for the chance of saving one year's crop.

Again, if the trunks of the vines be bored and the sulphur inserted, this most delicate operation could only be performed by the factors themselves, and if the vines were to be cut down to the ground and grafted with cuttings from sound vines, the entire operation (which could only be performed by the factors) would cost $1\frac{1}{4}d.$ to $1\frac{1}{2}d.$ for each vine, or as much as the sulphuring process; and besides this, there would be a loss of four years' produce at $3l.$ per pipe per annum, making a total loss of $16l. 10s.$ in every vineyard growing vines capable of yielding one pipe of wine, or about $33\frac{1}{3}$ per cent., or one-third of the freehold value of the estate.

Lastly, the dressing of the trunk and branches of 800,000,000 vines with mineral tar could not be carried into operation within any reasonable period, on account of the tediousness of the process and the scarcity of labourers. The expense of the tar would also be a bar to its being used.